National Ambient Air Monitoring Strategy

Summary Document

July 5, 2002 DRAFT ..Do Not Distribute

WHAT IS THIS DOCUMENT AND WHO IS IT FOR?
This volume summarizes the proposed National Air Monitoring Strategy, which has been in development for nearly three years. It represents the latest thinking on the part of EPA, state and local agency staff, and tribal representatives in how best to re-structure the nation's air monitoring programs responsive to the needs of the twenty-first century, yet balancing both national and state/local interests. It is primarily intended to help state and local air agency directors, tribal representatives, and their key personnel as it provides information to better understand the need, benefits, and process for implementing this Strategy. For similar reasons, this document can also be of benefit to environmental organizations, and the business/regulated community,

BACKGROUND

Ambient air monitoring systems are a critical part of the nation's air program infrastructure. To provide a backdrop for the new National Air Monitoring Strategy, the following information is provided:

- Ambient air networks are typically used to:
  --characterize local, regional, and national air quality conditions
  --assess health impacts
  --assess effectiveness of control programs
  --help form the basis for new control programs
  --assess source impacts
  --provide information to the public

- The United States spends well over $200 million annually on routine ambient air monitoring programs

- Ambient air measurements produced by state and local agencies and tribes (SLTs) are high quality, credible environmental data.

- Ambient air measurement networks have typically been developed by pollutant (e.g., an ozone network; a particulate network, etc.).

- Concentrations for many criteria pollutants have decreased substantially over time, and some pollutants now read well below national standards (Figure 1).

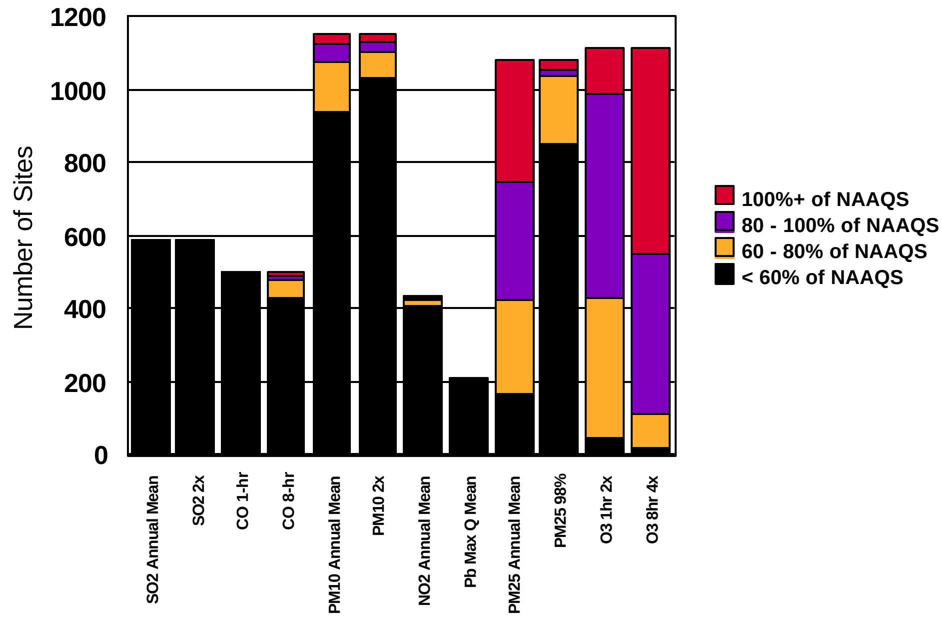

Figure 1. Number of monitors measuring values relative to the National Ambient Air Quality Standards based on AIRS data through 1999. Great progress has been made in reducing ambient concentrations of most criteria measurements. Ozone and PM2.5 dominate the non attainment picture on a national scale.

- An influx of recent scientific findings and technological advancements challenge the response capability of the nation's existing networks.

- Current designs tend to inhibit our ability to optimize numerous programmatic and technical linkages across ozone, fine particulate matter, regional haze, air toxics, and related multi-media interactions (e.g., atmospheric deposition).

- In 1999, the EPA convened a "National Monitoring Strategy Committee" (NMSC), comprised of representatives from EPA, state and local agencies, and tribes to begin a process for taking a holistic review of our nation's air monitoring networks and making recommendations for improving network design.

- The Draft Strategy Document is the culmination of that effort.

FORMAT OF THIS DOCUMENT

This summary is based on the information contained in the more extensive Draft National Air Monitoring Strategy Document (DSD), currently available for review. The summary document is presented in a question-answer format, with extended discussions provided along with the answers to some of the questions for those readers interested in more complete discussions.

Both this summary document and the full DSD are available for review and comment. Any comments should be submitted by October 31, 2002 to:

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The NMSC will review comments prior to finalizing the National Air Monitoring Strategy Document.

What is the National Air Monitoring Strategy (Strategy)?

The Strategy is a new approach to the nation's air monitoring programs. The overarching goal of the Strategy is "to improve the scientific and technical competency of existing air monitoring networks so as to be more responsive to the public, and the scientific and health communities, in a flexible way that accommodates future needs in an optimized resource constrained environment."

Stated another way, the Strategy is intended to re-shape the monitoring program in ways that can easily accommodate both national and local needs, improved information flow to the public, incorporation of new technologies and new pollutant measurements, and do this in a fiscally responsible manner.

What is the National Air Monitoring Strategy Committee (NMSC)?

The NMSC is a partnership committee among the EPA, SLTs and tribal representatives. There are 18 members: seven EPA management level staff; seven representatives from state and local agencies, including the State and Territorial Air Pollution Program Administrators/Association of Local Air Pollution Control Officials (STAPPA/ALAPCO); three tribal representatives; and one facilitator. Since 1999, NMSC members have been meeting on a regular basis to provide the framework for the Strategy. To that end, this document represents the culmination, collectively, of many hundreds of hours of discussions, informational reviews, problem solving, issue resolution, and consensus building.

How was the Strategy developed?

The NMSC established key elements to the Strategy which it deemed to be crucial to an effective program. These included a set of objectives (e.g., what the Strategy is intended to accomplish), specific components (e.g., what are the key functions that need to occur), attributes to some of the components (e.g., what the components are intended to accomplish), and an overriding set of operating principles (e.g., what are the constraints which must be considered). Together, these formed the complete framework for the Strategy, from which the details evolved.

What are the specific objectives?

The NMSC developed 12 key objectives:

- To manage the nation's air monitoring networks in a manner that addresses the most pressing public health issues, optimizes efficiency, and accommodates future needs, all within the constraints of the available funding.

- To establish a new air monitoring paradigm coupling a minimum level of required national monitoring with flexible state/local/tribal air monitoring networks in order to efficiently and effectively meet both national and state/local/tribal needs.

- To provide a greater degree of timely (e.g., real-time) public air quality information, including the mapping of air pollution data, and air quality forecasts.

- To promote network efficiencies through the reevaluation of regulations and quality assurance procedures.

- To foster the utilization of new measurement method technologies.

- To provide a mechanism for the periodic assessment, from both a national and local/regional perspective, of all air monitoring activities to help ensure the relevance and efficiency of the network. (This mechanism should provide appropriate flexibility to disinvest in monitoring activities should changing priorities so warrant.)

- To encourage multi-pollutant measurements, where appropriate, for better air quality management and scientific/health-based data sets.

- To provide a base air monitoring structure which, in conjunction with special studies (not part of this strategy), could be used to support certain regulatory needs, e.g., SIP development, source apportionment, operational model evaluation, and tracking progress of emissions reduction strategies.

- To develop and implement a major public information and outreach program as an important cornerstone toward network changes.

- To seek input from the scientific community as to the merit/value of proposed changes.

- To provide air monitoring platforms and data bases which can be used for other environmental purposes, such as area-based ecosystem assessments, global issues, diagnostic research, and biological sensing.

- To assess, periodically, funding levels needed to maintain support for this monitoring strategy, and incorporate recommendations into the budget planning process.

What are the key components of the Strategy?

There are six essential components:

- A science based design proposal referred to as the ***National Core Network (NCore)*** for national air monitoring networks that increases integrated multi-pollutant monitoring and facilitates the timely delivery of data, using state-of-the- art information technology systems, to the public and scientific communities.

- ***Technical assessments*** of the existing air monitoring networks that probe into the actual program support value of air quality data by considering factors such as monitoring site redundancy, relative concentration values, operational logistics and relevancy to current priorities.

- A ***restructuring*** of existing ***monitoring regulations*** to remove any obstacles that may impede progress and to accommodate current and forthcoming needs.

- A ***revised national quality assurance*** program focused on a performance based measurement system to meet multiple monitoring objectives.

- Proposals to ***enhance*** technical methods in air monitoring networks focused on ***continuously operating particulate matter and information transfer technologies***.

- A ***communications and outreach*** effort to explain the rationale and benefits of this strategy to all stakeholders.

These components collectively act (and interact) to promote changes in the existing network infrastructure.

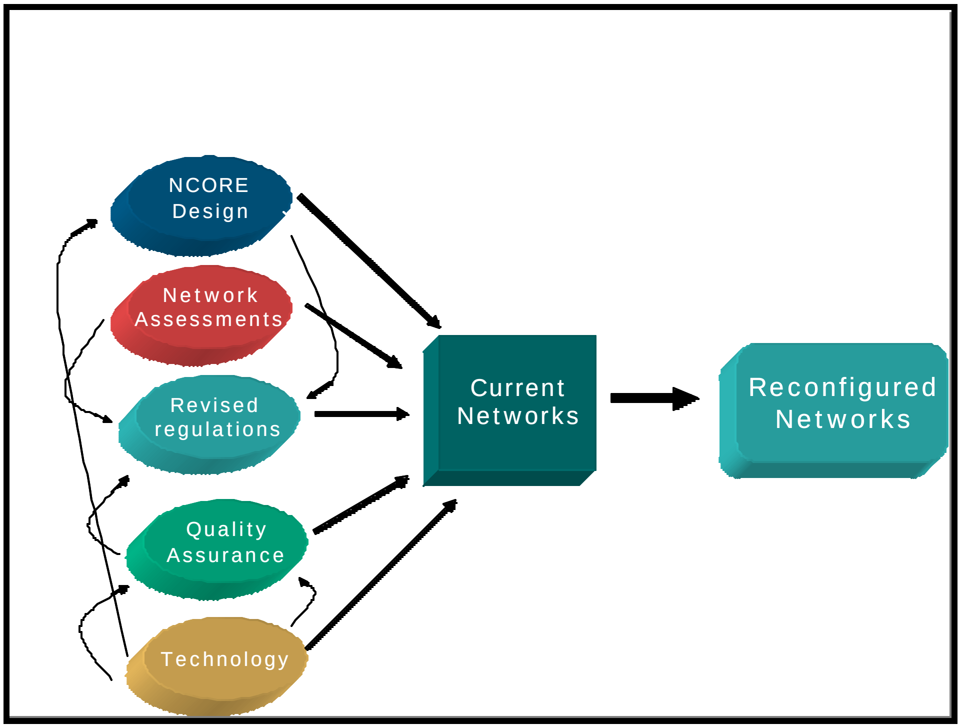


Figure 2. Information flow across monitoring strategy components.

What are the key operating principles and why do we need them?

The success of a major cooperative effort depends on defining the underlying principles to which all parties can accept. In formulating the Strategy, the NMSC constructed five operating principles and these were followed to the degree possible. The five key operating principles are as follows:

- ***Partnership***: Consensus building is used to corroborate strategic planning elements among EPA, state and local agencies, and tribes.

- ***Flexibility by balancing national and local needs***. Network design, divestment, and investment decisions must achieve a balance between prescription (consistency) and flexibility to accommodate national and local monitoring objectives. Although localized issues are "national" issues, and nationally consistent data bases serve local (state/tribe/local agency) interests, allowances must be made for differing needs arising from both perspectives. For example, while environmental justice is of national interest, specific air monitoring efforts to address environmental justice concerns of a local community is best handled through air monitoring flexibility at the local level.

- ***Effective interfacing with "science."*** An emphasis should be placed on more active engagement with the scientific community, recognizing the important role science plays in network design and technology and the role of networks in assisting scientific research. The perspective that a clear demarcation exists between science-oriented and agency-based monitoring is counterproductive to the larger goal of optimizing the value of air monitoring programs.

- ***"Zero-sum" resource assumptions***. This strategy is not a vehicle to add significant resources for air measurements. Relatively stable but flat spending is projected for air monitoring activities. This level resource assumption can accommodate new air monitoring needs by targeting reductions in current monitoring, primarily for pollutants which are now well below the NAAQS. The strategy includes very modest resource proposals (i.e., an insignificant fraction of current monitoring resources) required to catalyze certain technology elements of this strategy. Furthermore, this strategy intends to retain the basic infrastructure and operational stability of existing agencies. Reallocation implies shifts to different pollutant measurements and technologies, and not resource shifts across geographical regimes.

- **Data analysis and interpretation**. Too often large data collection programs sacrifice data analysis tasks due to a lack of protected or dedicated analysis resources, available guidance and expertise, or declining project interest (which often peaks at program start up). The PAMS program, for example, suffered from these effects, which were compounded by a lack of patience associated with a desire for short-term results from a program designed to address long-term trends. By contrast, a good example has been established by the emerging air toxics program which has set aside significant resources for analysis of historical and new pilot city data prior to large scale network deployment. Networks will operate more efficiently when periodic active analyses are performed that identify strengths and weaknesses and provide more dynamic direction for modifications.

What is the expected scope of participation for developing the Strategy?

Though the NMSC has been the primary partnership unit to develop the draft version of the strategy, clearly, the scope of this effort must expand to other entities as numerous leveraging and common interest opportunities exist with industry, other federal agencies and the international community. This expansion has started through discussions with NARSTO, the Committee for Environment and Natural Resources (CENR), PM health and Supersite principal investigators, and initiation of Scientific Advisory Board review. Comments and input are also welcomed from the entire SLT entities, as well as the public and other interested groups. This current effort should be perceived as the foundation for the full Strategy.

What's wrong with the existing air monitoring network structure?

Nothing is "wrong" with the current networks. They are providing valuable information. However, as we look to the future and the changing needs for air quality data to meet new challenges, such as air toxics, more continuous data for public advisories and health-based assessments, the current single-pollutant networks are not well structured to adapt in an efficient manner. The long-held approach for layering new networks on top of old networks will not adequately meet the emerging demands upon air monitoring expansion under current and projected resource constraints. It is necessary, then, to look at new ways of optimizing existing resources while accommodating additional needs and uses for air monitoring data, while at the same time, providing much greater value to the public.

Extended Discussion – Overview of the Existing Air Monitoring Networks

The major routinely operating ambient air monitoring networks in the United States include a collection of programs primarily operated by states, local agencies and tribes:

State and Local Air Monitoring Stations (SLAMS) and National Air Monitoring Stations (NAMS).

> *SLAMS and NAMS represent the majority of all criteria pollutant (SO_2, NO_2, CO, O_3, Pb, $PM_{2.5}$, PM_{10}) monitoring across the nation with over 5000 monitors at approximately 3000 sites. These stations use Federal reference or equivalent methods (FRM/FEM) for direct comparison to the NAAQS. Design and measurement requirements for these networks are codified in the Code of Federal Regulations (CFR) parts 58 (design and quality assurance), 53 (equivalent methods) and 50 (reference methods). NAMS are a subset of SLAMS that are designated as national trends sites. The NAMS and SLAMS were developed in the 1970's with a major addition of $PM_{2.5}$ monitors starting in 1999 associated with promulgation of the 1997 PM NAAQS. These networks experienced accelerated growth throughout the 1970s with most components exhibiting declines in the number of sites with the exception of ozone and $PM_{2.5}$ (Figure 3,and also Table 1). Rethinking the design of SLAMS/NAMS is a central topic of this strategy.*

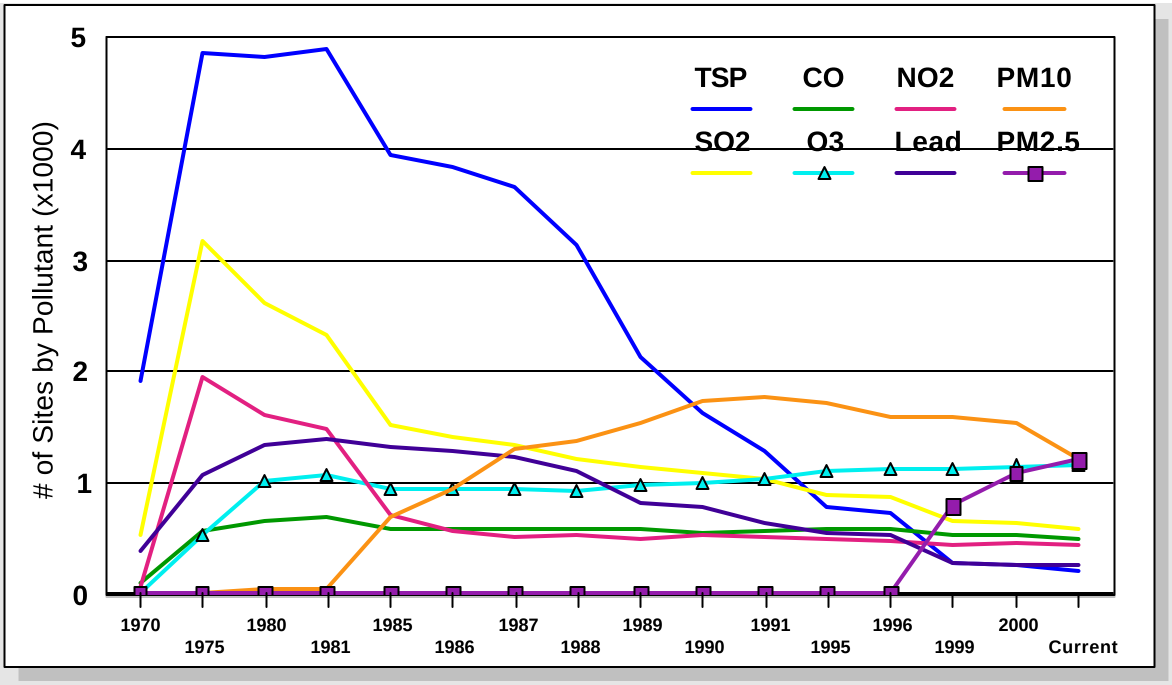


Figure 3. Growth and decline of criteria pollutant networks.

PM2.5 networks

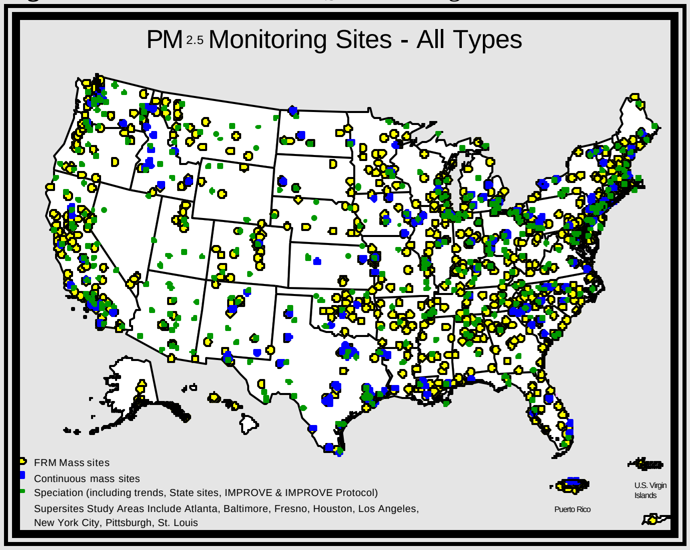
The PM2.5 networks includes three major components (Figure 4):

1) ***mass only measurements*** *through nearly 1100 FRM filter based mass sites that measure 24 hour averaged concentrations through gravimetry, and approximately 200 continuously operating mass sites using a range of technologies,*

2) ***chemical speciation measurements*** *that consists of approximately 50 trend, 250 State Implementation Plan (SIP) and 150 IMPROVE sites, respectively. The vast majority of these sites collect aerosol samples over 24 hours every third day on filters that are analyzed for trace elements, major ions (sulfates, nitrates and ammonium) and organic and elemental carbon fractions. Most of the IMPROVE sites are operated by personnel from the Federal Land Management (FLM) and Forest and National Park Services. Over the last five years these networks have been subject to reviews by the National Academy of Science (NAS), EPA's Clean Air Scientific Advisory Committee (CASAC), the General Accounting Office (GAO) and the Inspector General's Office. The CASAC review by the particle monitoring subcommittee has been engaged with EPA since 1999. Many of the recommendations related to the introduction of new methodology, particularly increased continuous particle monitoring and the corresponding need to redirect resources from FRM filter methods to continuous and speciation sampling have been addressed in detail through the CASAC subcommittee on particulate matter monitoring, and*

*3) **8 Supersites** executed as cooperative agreements with Universities and EPA that (city dependent) operate over various periods spanning 1999 to 2003 and conduct a wealth of standard and research grade measurements.   Supersites are designed to address the extremely complicated sampling issues associated with fine aerosols and constitute an ambitious technology transfer and liaison effort across research level and routine network operations.*

Figure 4. Distribution of $PM_{2.5}$ monitoring sites.



Clean Air Status and Trends Network (CASTNET)

CASTNET originally was designed to account for progress of strategies targeting major electrical generating utilities throughout the Midwest which release acid rain precursor emissions, sulfur and nitrogen oxides.   Network operations are contracted out to private firms funded through Science and Technolgy (S&T) funds and managed by EPA's Office of Air and Radiation.   CASTNET consists of approximately 70 sites located predominantly throughout the East with greatest site densities in States along the Ohio River Valley and central Appalachian Mountains.   Aggregate two week samples are collected by filter packs and analyzed for major sulfur and nitrogen oxide transformation compounds (e.g., end products such as sulfate and nitrate ions).   CASTNET was deployed in the 1980s as part EPA's National Acid Precipitation Assessment Program (NAPAP). A network assessment in the mid-1990's lead to a more optimized and less extensive network.

Photochemical Assessment Measurement Stations (PAMS).

PAMS measures ozone precursors {volatile organic compounds (VOC) and nitrogen oxides (NOx) } which react to form ozone at 75 sites in 25 metropolitan areas that were classified as serious ozone non-attainment coincident with release of the 1990 Clean Air Act

(CAA) amendments. The addition of PAMS in the early to mid 1990's was a major addition (and burden to State and local agencies) to the national networks, introducing near research grade measurement technologies to produce continuous data for over 50 VOC compounds during summer ozone seasons. PAMS has been subject to numerous concerns regarding data quality and lack data analysis applications. More recent efforts have explored stronger linkage to air toxics monitoring as well as identification of more streamlined PAMS requirements (Chapter 4).

Air Toxics Monitoring Network.

Nearly 250 air toxics sites have been operated by State and local agencies largely through their own initiatives and funding as there are no Federal requirements for air toxics monitoring, and only recently have Federal Grant funds been earmarked for toxics monitoring. A steering committee consisting of EPA, State and local agency members has been developing a National Air Toxics monitoring program. The program design effort is starting with a detailed analysis of data from existing sites and recently deployed pilot studies (measuring 18 species) at four major urban locations (Providence, RI; Tampa, FL; Detroit, MI; Seattle, WA) and six small city/rural locations (Puerto Rico; Keeney knob, WV; Cedar Rapids, IA; Grand Junction, CO; Rio Rancho, NM; San Jacinto, CA). While air toxics clearly is a problem of national scope, the problems are highly variable and dependent on local conditions (i.e., emissions mix, topography, meteorology). A majority of resources should be under the discretion of state/local agencies, and Tribes to accommodate the variable and localized nature of air toxics across the nation. A fraction of the program will support a national trends network that measures a limited number species at perhaps 20-30 locations. The steering committee has recommended an initial 11 urban sites to start this network.

Table 1. Summary table of national ambient air monitoring networks.

SLAMS/ NAMS	Approximate Current number of sites	% measuring > 60% NAAQS	Historical high # sites	sampling reporting freq. (year round unless noted)	notes
Ozone	1167	> 80 (8 hr)	1167 (2002)	hourly (May - September)	
PM2.5	1200	>75	1200 (2002)	24- hr average; mix of daily, every third day and every sixth day	
PM10	1214	< 25	1763 (1991)	mix of 24-hr. avg, every sixth day; and hourly	
SO2	592	< 5	3158 (1975)	hourly	
NO2	437	< 5	1944 (1975)	hourly	
CO	498	< 5	684 (1981)	hourly	
Pb	247	< 5	1393 (1981)	24-hr. avg, every 6thday	
TSP	215	NA	4894 (1981)	24-hr. avg, every 6th day	
PM2.5					
FRM mass	(1100)				as above
Continuous mass	200	NA		hourly	
Speciation	54 Trends; 160 SIP 140 IMPROVE	NA		mostly 24-hr avg; every third day	major ions (sulfate, nitrate, ammonium); carbon fractions (organic and elemental); trace metals
PAMS	77 sites in 25 MSAs	NA		mix of hourly, 3-hr avg and 24 hour average (56 VOCs, TNMOC and carbonyls throughout ozone season	ozone and NO2 include in SLAMS/NAMS;
Toxics	280 (10 National Pilot sites)	NA		broad range of metals, VOCs, SVOCs Pilots: 18 species (metals, VOCs, aldehydes); 24-hr avg, every 6th or 12th day	
CASTNET	70	NA		total nitrate, sulfate, ammonium 2-week avg. samples collected continuously	ozone and IMPROVE measurements included above

Why do ambient air networks need to produce more meaningful data?

The historical emphasis on compliance type measurements used mostly to compare to the National Ambient Air Quality Standards (NAAQS) must be expanded to better service timely data reporting to the public, account for the effectiveness of major emission reduction programs, and support health assessments. Importantly, the networks must be more supportive of predictive air quality model applications. Compliance measurements using federal or equivalent methods have typically been the focus for air monitoring, compromising our ability to collect more robust and insightful data. Program areas requiring more insightful data include: hazardous air pollutants (HAPs) which project to be more important air quality concerns than all current criteria pollutants; continuous gaseous and particulate matter data to support public reporting needs; and integrated multi-pollutant assessments. Our ability to truly account for progress in major programs such as the NOx State Implementation Plan (SIP) call, multi-pollutant initiatives, and acid rain legislation is dependent upon our ability to obtain a greater level of information than the current networks provide. Also, peripheral benefits and knowledge will be derived through the pursuit of more diagnostic level measurements underlying air pollution behavior.

What elements need to be added to the existing air monitoring networks?

To meet the challenging needs for air monitoring in the twenty-first century, technological advances in information transfer, quality control, continuously reading high- sensitivity instruments, and merging of predictive air modeling tools into the monitoring networks must be accommodated.

New measurement, data transfer and quality control technologies are available to address a variety of data objectives. More than 75% of all monitoring resources are devoted to time-integrated sampling systems such as particulate matter filter media or gas canisters for VOCs with a 6-month (or more) lag in final reporting. Near-continuously reading instruments and the hardware and software to transmit data improve our understanding of the behavior of air pollutants over shorter time periods and deliver information at its most relevant point (now) while reducing labor demands on an overburdened work force. Many current monitors were designed to capture “high” concentrations. Reduced air pollution concentrations challenge many current monitors, as it typically is easier to achieve high instrument performance with elevated concentrations. Advanced versions of monitors that capture concentrations “representative” of today’s air quality must replace instrumentation based on design needs two decades old. Finally, the predictive air quality modeling tools must be better married to the measurements. While it is not cost effective to *sample* everywhere all of the time, advances in computational systems will make it possible and eventually practical to *predict* air quality with its variety of chemical and physical attributes nearly every place all of the time. The dominating concerns of model accuracy can be abated somewhat by merging measured data in the models through an iterative “correction” process which nudges modeled predictions toward observations. This practice occurs regularly with advanced meteorological models which incorporate observed surface and upper air meteorological measurements directly into the predictive models.   There is no *technological* reason why interactive model-measurement information could not be available for broad range of pollutants for informing on today's, yesterday's (and last year, decade..), and tomorrow's (and next year, next decade) air quality conditions.   This integrated approach could be viewed as the future "AIRNow" that substantially increases delivery of information.

What are the advantages of establishing multiple pollutant measurement systems to address integrated air program management?

Scientific findings over the last two decades continue to reinforce the need for comprehensive air quality management practices as air pollution processes are interwoven across various pollutant groups (e.g., ozone, PM, toxics) either through common emission sources, atmospheric chemistry processes, and meteorological and transport phenomena.   Health studies and air quality models all benefit from multiple measurements at a variety of locations representing disparate geographic and source regions and spanning ranges of population.   The majority of sites measure just one or two pollutants.   Historically, there has not been a concerted effort to coordinate monitoring across pollutant groups, as the networks were driven by a series of single pollutant NAAQS promulgations.   This current strategy allows for a more explicit, holistic network design to address air quality management comprehensively.   The National Core network (**NCore**) is proposed as a new network design that utilizes the best features of existing networks with specific multiple pollutant measurement components.

Why is it important to try to accommodate hazardous air pollution measurements?

As criteria pollutant levels continue (and are predicted to) to decline, there is a concurrent increase in the relative importance of residual concerns associated with hazardous air pollutants. There currently are 188 hazardous air pollutants (HAPs), or air toxics, regulated under the Clean Air Act (CAA) that have been associated with a wide variety of adverse health effects, including cancer, neurological effects, reproductive effects, and developmental effects, as well as ecosystem effects.   These air toxics are emitted from multiple sources, including major stationary, area, and mobile sources, resulting in population exposure. While in some cases the public may be exposed to an individual HAP, more typically people experience exposures to multiple HAPs and from many sources. Exposures of concern result not only from the inhalation of these HAPs, but also from multi-pathway exposures to air emissions.   For example, air emissions of mercury are deposited in water and people are exposed to mercury through their consumption of contaminated fish. Given these variety of concerns and numerous HAPs, there is a need for expanded monitoring capacity with flexibility as the primary air toxic conditions can vary greatly from one area to another. Air toxics monitoring will support long term trends analyses, general air quality "characterizations," and evaluations of predictive air quality models.   Current air toxic monitoring pilot studies and data analyses, discussed above, will culminate in network design recommendations in 2003.

What is NCore?

NCore is the key component of the new air monitoring strategy which accounts for the air monitoring issues and concerns stated in the preceding five questions. NCore provides an opportunity to address new directions in monitoring and begin to fill measurement and technological gaps that have accumulated in the networks. The strategy recognizes that there are both nationally and locally oriented objectives in air monitoring that require different design approaches, despite our best attempts at leveraging resources and maximizing versatility of monitoring stations. NCore takes a more proactive approach at addressing national level needs that often had to make the most of available data sources, regardless of their design basis. NCore introduces a new multi-pollutant monitoring component, and addresses the following objectives:

- **Foster the utilization of continuous monitoring technology**
- **Provide timely reporting of data to public** by supporting AIRNow, air quality forecasting and other public reporting mechanisms
- **Support the development of emission strategies** through air quality model evaluation and other observational methods
- **Provide accountability of emission strategy progress** through tracking long term trends of criteria and non-criteria pollutants and their precursors
- **Support long term health assessments** that contribute to ongoing reviews of National Ambient Air Quality Standards
- **Evaluate compliance with NAAQS** through better establishment of non-attainment/attainment areas
- **Support scientific studies** ranging across technological, health and atmospheric process disciplines
- **Provide a consistent national network of multi-pollutant sites**
- **Provide consistent air quality information for both urban and rural areas**
- **Accommodate the national needs for monitoring new pollutants**
- **Maximize the leveraging of existing air monitoring sites and resources**, especially those with multi-pollutant capabilities
- **Provide a basis from which local augmentation can meet local air monitoring priorities**

Extended Discussion – (1) Use of Continuous Monitors; (2) Diversity of Representative Locations; and (3) Collocated Multi-pollutant Measurements

Use of Continuous Monitors

Continuous systems allow for immediate data delivery through state-of-the-art telemetry transfer and support reporting mechanisms such as AIRNOW and a variety of public health and monitoring agencies charged with informing public on air quality. Continuous data add considerable insight to health assessments that address a variety of averaging times, source apportionment studies that relate impacts to direct emission sources, and air quality models that need to perform adequately over a variety of time scales to increase confidence in projected emissions control scenarios

Diversity of "Representative" Monitoring Locations

(e.g., the need to monitor across urban (large and medium size cities) and rural (background and transport corridors) areas:

National level health assessments and air quality model evaluations require data representative of broad urban (e.g., 5 to 40 km) and regional/rural (> 50 km) spatial scales. Long term epidemiological studies that support review of national ambient air quality standards benefit from a variety of airshed characteristics across different population regimes. The NCore sites should be perceived as developing a representative report card on air quality across the nation, capable of delineating differences among Geographic and climatological regions. While "high" concentration levels will characterize many urban areas in NCore, it is important to include a cities that also experience less elevated pollution levels or differing mixtures of pollutants for more statistically robust assessments. It also is important to characterize rural/regional environments to understand background conditions, transport corridors, regional-urban dynamics, and influences of global transport. Air quality modeling domains continue to increase. Throughout the 1970's and 80's localized source oriented dispersion modeling evolved into broader urban scale modeling (e.g., EKMA and Urban airshed modeling for ozone) to Regional approaches in the 1980's and 1990's (e.g., Regional Oxidant (ROM) and Acid Deposition (RADM) Models to current national scale approaches (Models 3- CMAQ) and eventually to routine applications of Continental/global scale models. The movement toward broader spatial scale models coincides with increased importance of the regional/rural/transport environment on urban conditions. As peak urban air pollution levels decline, slowly increasing background levels impart greater relative influence on air quality. Models need to capture these rural attributes to be successful to provide accurate urban concentrations.

Collocated multiple pollutant measurements

Air pollution phenomena across ozone, particulate matter, other criteria pollutants, and air toxics are more integrated than the existing single pollutant program infrastructure suggests. From an emissions source perspective, multiple pollutants or their precursors are released simultaneously (e.g., combustion plume with nitrogen, carbon, hydrocarbon, *mercury and sulfur gases and particulate matter). Meteorological processes that shape pollutant movement, atmospheric transformations and removal act on all pollutants. Numerous chemical/physical interactions exist underlying the dynamics of particle and ozone formation and the adherence of air toxics on surfaces of particles. The overwhelming programmatic and scientific interactions across pollutants demand a movement toward integrated air quality management. Collocated air monitoring will benefit health assessments, emission strategy development and monitoring. Health studies with access to multiple pollutant data will be better positioned to tease out confounding effects of different pollutants, particularly when a variety concentration, composition and population types are included. The tools for strategy development (e.g., air quality models and source attribution methods) provide benefit by performing more robust evaluations (e.g., checking performance on several variables to ensure model produces results for correct reasons and not through compensating errors). Just as emission sources are characterized by a multiplicity of pollutant release, related source apportionment models yield more conclusive results from use of multiple measurements. Monitoring operations benefit by a streamlining of operations (concentrated effort on measurements) and multiple measurements potentially can diagnose factors affecting instrument behavior. In addition, as we move aggressively to integrate continuous PM (mass and speciation) monitors in the network, it is important to retain a number of collocated filter and continuous instruments as the relationships between these methods now are subject to future changes brought on by modifications of aerosol composition (e.g., as nitrate replaces sulfate, assuming proportionally greater sulfur reductions, as the major inorganic component, aerosol sampling losses due to volatility may increase at different rates dependent on instrument type.*

How is NCore Structured?

NCore is structured as a three-tiered approach, Levels 1-3. (See Figure 5) based on measurement complexity, with Level 1 being the most sophisticated, and Level 3 being the least. Level 1 “master” sites would serve a strong science and technology transfer role for the network, and it is estimated that 3 to 10 such sites nationally would serve this purpose. The Level 2 sites would be the “backbone” of NCore, with approximately 75 such sites nationally. These sites would add a new multiple pollutant component to the networks with a minimum set of continuously operating instruments that, in many areas, would benefit form placement at existing PM speciation, PAMS or air toxics trends sites. Level 3 sites are largely single-pollutant sites, emphasizing the need for spatially rich network primarily for the most ubiquitous criteria pollutants, $PM_{2.5}$ and ozone, and addressing an assortment of compliance related needs. Progressing through Levels 1 through 3, the character of these sites moves from a strong science orientation toward compliance.

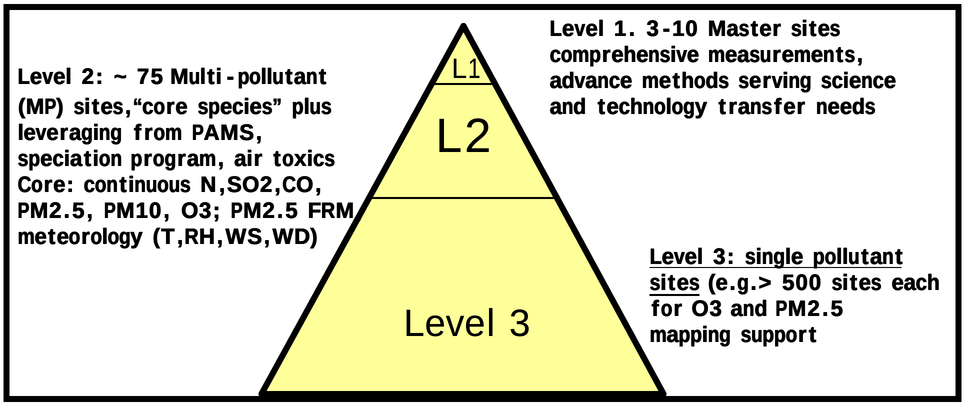


Figure 5. NCORE tiering levels.

NCore also includes a local component. These sites complement the three-tiered monitoring sites by meeting monitoring objectives of local concern. These may include “hot spot” monitoring; use of mobile platforms for greater community coverage; source-specific monitoring; addressing environmental justice concerns; tracking non-criteria pollutants of local concern; local characterization of key pollutants; and other local needs. This component gives state and local agencies greater flexibility in addressing both national and local air monitoring issues.

Extended Discussion – The Three Levels of NCore

Level 1.

A small number (3-10) of Level 1 (master) sites would include the most comprehensive list of routine measurements (most complete Level 2 site with PAMS, PM speciation and air toxics trends), research level measurements with potential for routine application (e.g., PM size distribution, nitric acid, ammonia, true NO2), and additional measurements dependent on area specific priorities, available expertise, and resources. These sites would serve three needs: (1) a comprehensive suite of measurements providing the most insightful of all routine air monitoring networks; (2) a technology transfer mechanism to test emerging methods at a few locations with disparate conditions that eventually would find more mainstream application (e.g., true nitrogen dioxide measurements should be part of routine operations; however, field testing and demonstration efforts must precede application in routine networks. Consideration for routine applications should be given to other measurements such as continuous ammonia, nitric acid, particle size distributions); and (3) a bridge across routine applications and science.

Over the last ten years the U.S. EPA’s Office of Research and Development gradually has decreased its level of methods development and testing to a point where it no longer is considered a leader in this field. Methods testing now is conducted through a rather loose collection of State-sponsored trials, especially California’s Air Resources Board, vendor sponsored initiatives, miscellaneous research Grants, and agreements to Universities (e.g., PM Supersites and health centers), combined with a skeleton level effort of internal EPA testing. The Supersites program does fulfill some of the needed technology transfer needs, but is of short duration and mostly focused on broad array of particle characterization issues in addition to technology testing. Level 1 sites would be one component addressing this national level weakness that needs attention. State agencies cannot continue to be burdened with being "trial" testers of new methods. More importantly, we cannot afford to lose the opportunities in greatly enhanced data value that emerging technologies present.

Level 2.

Level 2 measurements represent the mainstream multiple pollutant sites in the network and best reflect the design attributes discussed above. The approximate total number (75) of sites as well as proposed measurements are modest recommendations and attempt to constrain total network growth and introduce a reasonable and manageable realignment in the networks.   Site locations will be based on design criteria that balance technical needs with practical considerations such as leveraging established sites and maintaining Geographic equity.

The minimum recommended measurements (all via near-continuous monitors reporting at 1-hr. interval or less) include gaseous sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen oxide and total reactive nitrogen (NO and NOy)[1]*, ozone (O3); and particles with size cuts less than 2.5 and 10 microns, ($PM_{2.5}$) and (PM_{10}), respectively. Additional parameters include filter based $PM_{2.5}$ (with FRMs) and basic meteorological parameters (temperature, relative humidity, wind speed and direction).   While these parameters include most criteria pollutants (except for nitrogen dioxide, NO_2, and lead, Pb), they are not chosen for compliance purposes.   They represent a robust set of indicators that support multiple objectives, including accountability, health assessments, and emissions strategy development (e.g., air quality model evaluation, source apportionment and numerous observational model applications). In most cases, these minimum measurements will be accompanied existing measurements (e.g., aerosol sulfate from the speciation program combined with gaseous SO_2 provides valuable insight into air mass aging and transformation dynamics).*

The continuous PM measurements are not expected to use FRM monitors (i.e., currently, no $PM_{2.5}$ continuous monitor has equivalency status). The reason for specifying continuous methods for PM has been addressed at length. The intention here is not to produce independent PM_{10} values, but to provide a mechanism to develop an organized and consistent $PM_{(10-2.5)}$ data base that will be supportive of health studies and emission strategy development.   As a peripheral benefit, the development of this database should meet equivalency testing requirements for a PMcoarse method and perhaps be viewed as the default "regulatory" method for PMcoarse.   Collocation with FRMs is an important component of the $PM_{2.5}$ continuous implementation strategy as the relationship between FRMs and continuous monitors drives the integration of these systems. These relationships will vary in place and time as a function of aerosol composition (e.g., gradual evolution of a more volatile aerosol in the East as carbon and

[1] NO and NOy are chosen as they provide indicators for realatively fresh (NO) and aged (NOy) emissions. They serve a critical tole in accounting for progress in large scale nitrogen emission reduction programs (e.g., Nox SIP calls and Clear Sky Initiative, CSI), provide input for a variety of observational based and source apportionment models, and assist evaluation of air quality models.   True nitrogen dioxide, NO2, should be added as a core measurement.   However, the lack of affordable and routinely operational instrumentation prevents such a recommendation at this time.

nitrate fractions increase relative to more stable sulfate fraction).

Level 3

The Level-3 sites are the most numerous of the three tiers, but are focused generally on the most important of the criteria pollutants. These augment the Level-2 site network, and are sometimes referred to as "adjunct sites." Primarily dedicated to defining needed information for non-attainment areas, many of the Level-3 sites will still be single-pollutant, and mainly targeted to PM and ozone. Such sites will help define the non-attainment areas and boundaries, monitor in areas with the highest concentrations, the greatest population exposure, provide information in new growth areas, meet SIP needs, and evaluate local background conditions. It is expected that over 1,000 such monitoring sites will be part of the Level-3 network, many of them already functioning as part of the current air monitoring program.

Extended Discussion – Relationship Between NCore and Existing Networks

Excluding CASTNET and IMPROVE, the existing networks[2] largely consist of NAMS/SLAMS and special purpose/supplemental monitoring for criteria pollutants, PAMS, non FRM portions of $PM_{2.5}$ network (e.g., speciation, supersites, and continuous mass) and air toxics. Most of these networks include a combination of prescriptive and less prescriptive monitoring based on relatively direct language in 40 CFR Part 58 of the monitoring regulations or through specific guidance in the Federal 103/105 Grants. The more prescriptive aspects include NAMS (all criteria pollutants), $PM_{2.5}$ SLAMS, PAMS, speciation trends and the emerging air toxics national trends sites. Less prescriptive elements not included in the monitoring regulations (i.e., "local-flexible" component) include special purpose/supplemental monitoring, SLAMS (other than $PM_{2.5}$ mass), $PM_{2.5}$ speciation beyond trends and a variety of air toxics sampling. Note that the estimated local fraction of resources for a particular program element is greatest for air toxics followed by $PM_{2.5}$ speciation (Table 3). While much of the SLAMS monitoring for criteria pollutants is not required in CFR Part 58, over time the monitoring has taken on a "required" context associated with various Clean Air Act requirements (e.g., design value sites, maintenance plan provisions, new source review, miscellaneous arbitration).

*A **rough** comparison of NCore with existing networks suggests: Level-1- - PM supersites; Level-2 - - criteria pollutant NAMS, speciation trends, air toxics trends, PAMS site 2; Level-3 - - SLAMS criteria pollutants. Several qualifying remarks are appropriate. The Supersites program is temporary and funding to transition into Level-1 master sites is not identified. Level-1 sites should be an integral long-term network component, and operate with greater intersite consistency than the current Supersites. The minimum requirements determining criteria pollutant trends (analogous to NAMS) in most cases would be accomplished through Level-2 sites. It is expected that the majority of speciation trend sites will be selected as Level-2 sites. The emerging national air toxics trend sites (NATTS) are being collocated at existing*

[2] not including CASTNET and IMPROVE; networks referred to are limited to those driven by Federal 103 and 105 Grants and operated by State/local agencies and Tribes that are more directly impacted by CFR part 58.

speciation sites (mostly trend sites), which in turn should emerge as formal NCore Level-2 sites. Approximately 50% of the remaining PAMS type-2 sites also serve as likely candidates for NCore Level-2, as many of these already are collocated with speciation trend sites. Note that major fractions of air toxics, PAMS and PM speciation are not part of NCore and should be viewed as part of the "local" network.

Table 3. Relationship between existing networks and NCORE

	NCORE Level 1	NCORE Level 2	NCORE Level 3	Local	other	notes
PM Supersites	T					lacking future funds
NAMS (CO, NO2, O3, SO2, PM10, PM2.5)		T				specified Level 2 PM2.5, PM10, NO/NOy do not use equivalent methods (assume each site has PM2.5 FRM; cont. PM10 and PM2.5 evolve into equivalent PMc)
SLAMS			T			
PM speciation trends		T			T	assumes most (not all) trend sites are Level 2 locations
PM speciation (SIP)				T		
Air toxic trends	T					
Air toxics				T		
PAMS type 2		T		T		unknown number of PAMS sites for Level 2
other PAMS				T		

How Will NCore Site Locations Be Determined?

There is a multi-step process for determining where NCore sites will be located. First, a set of criteria has been developed by the NMSC, and each candidate site must meet these to the degree possible. Next, an allocation process has been proposed for the Level-2 sites to assure that the objectives of NCore are satisfied, and at the same time assuring a level of equity among the States. Lastly, each participating state or local agency, or tribe will be responsible for actually determining the location of the Level-2 and Level-3 sites, but will need EPA approval for these recommendations.

What are the Siting Criteria for NCore Level 1-3 Sites?

NCore Level 1 sites are an important bridge for technology transfer and corroboration between research and regulatory oriented organizations. These sites should include a range of representative locations across the nation (e.g., allocating one site per EPA region). Candidate locations include existing supersites and other well-developed platforms capable of accommodating sufficient space for instruments with adequate power and security. Consideration should be given to developing a rural-based master site to ensure that technologies tested today can meet future conditions as concentration levels continue to decline.

The siting goal for Level-2 NCore sites is to produce a sample of representative measurement stations to service multiple objectives. Siting criteria include:

Collectively

- approximately 75 locations predominantly urban and 10-20 rural/regional sites

- *for urban*, a cross section of urban cities, emphasizing major areas with more than 1,000,000 (1M) population, and including mix of large (500,000 - 1M) and medium (250,000 – 500,000) cities, with geographically and air quality diverse locations suitable as reference sites for long term epidemiological studies

- *for rural*, capturing important transport corridors, both internal U.S. and international (Canada and Mexico), as well as intercontinental and background (e.g., regionally representative) conditions. In addition, some sites should allow for characterizing urban-regional coupling (e.g., how much additional aerosol does the urban environment add to a larger regional mix).

Individually

- determining "representative" locations not impacted by local sources (e.g., urban sites, 5-40 km; rural sites, > 50 km)

- leveraging with existing sites where practical, such as the speciation, air toxics and PAMS networks, and Clean Air Status (CASTNET) trends sites.

- consistency with collective criteria (i.e., does the selected site add holistic network value)

- other factors (e.g., agency capabilities; level of Tribal participation).

How Will the 75 or so Level-2 Sites be Selected?

Level 2 network design is initiated by first considering a cross section of urban locations to support long term epidemiological studies, adding additional rural locations to support national air quality modeling evaluation and emissions strategy accountability assessments followed by a practical mapping of these general locations with existing sites and an equitable/objective allocation scheme. This sequential approach is captured in Figure 6. Nearly 80 "representative" air quality regions that group populations based on statistical and geographic factors form a cross section of desired areas for long-term epidemiological studies. An additional 24 rural locations are identified to support evaluation of the national Community Modeling Air Quality System (CMAQ). These locations can be compared with available site candidates from existing networks (e.g., PM speciation, PAMS type 2 and CASTNET) that were designed with "representative" siting conditions commensurate with NCore Level-2 criteria. This procedure provides a modest objective-based reference to judge the adequacy of site allocation process (see below).

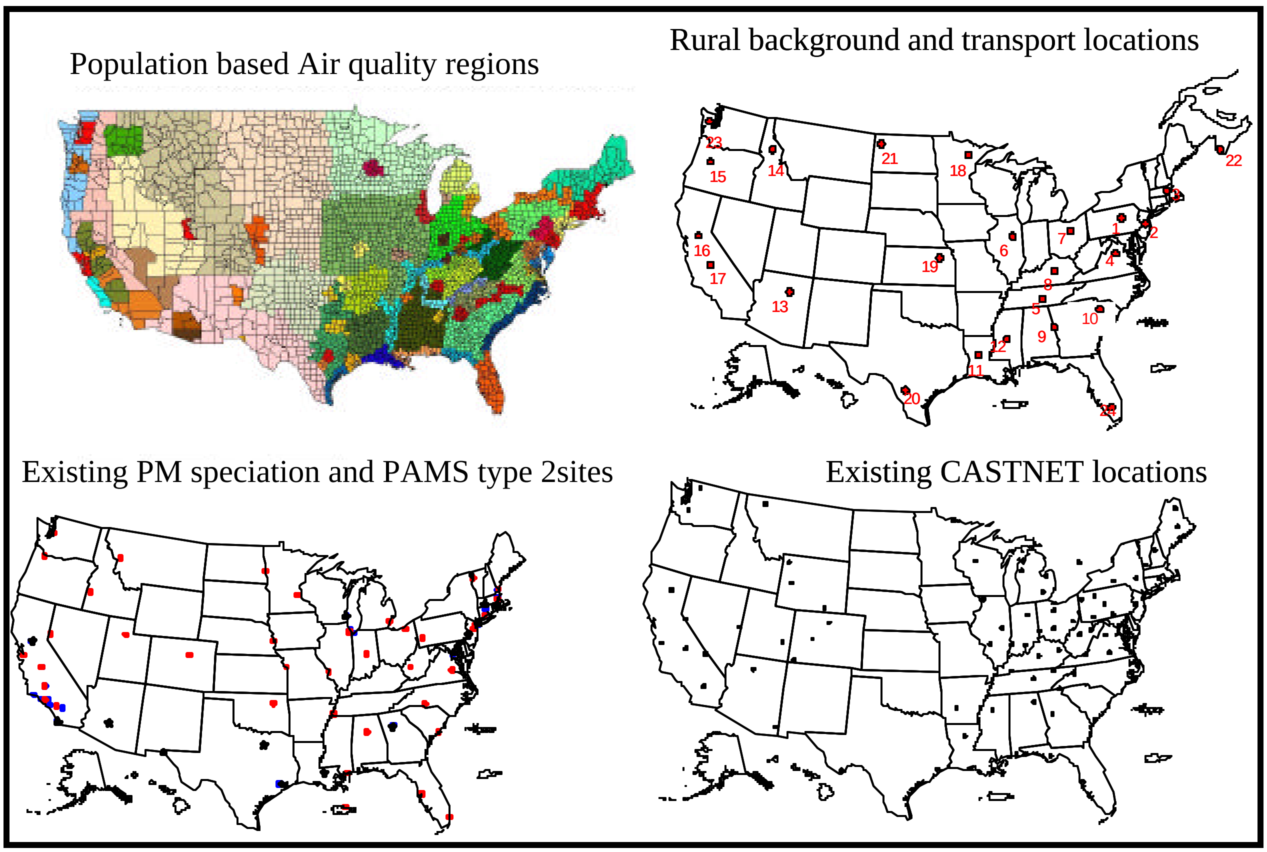


Figure 6. Maps (top) suggesting site locations based on health assessment and model evaluation needs, and locations (bottom) of existing stations with design criteria compatible with NCORE Level 2 sites.

The allocation scheme (summarized in Table 2) is based largely on historical and political considerations (e.g., one Level-2 site per state) that distributes monitoring resources based on a combination of population and geography, which in broad terms is consistent with several technical design aspects. Technical guidance sets a framework for assessing the development of NCore, while the allocation scheme provides a process for facilitating implementation. This allocation scheme is an initial proposal and generally provides a sweeping range of metropolitan areas. Clearly, allocation must be flexible enough to ensure that sites add meaningful value and avoid redundancies. Suspected shortcomings in the proposed allocation scheme that need to be reconciled include, for example, a lack of rural locations in California, lightly populated western states that may not provide a meaningful rural location, multiple Florida locations with generally moderate air quality due to marine influences, and possible redundant locations along the East Coast and Midwest. Level-2 sites will require approval by the EPA administrator (or delegate), a technical tool to insure that the collective national siting criteria are adhered to. An NCORE subcommittee of the larger NMSC will remain in place to site locations and facilitate site selection approval.

Table 2. Proposed NCORE Level 2 site allocations.

	total	major cities > 1M	large cities 500K - 1M	medium cities 250 -500K	rural
1 per state minimum	50				
3 each in most populated states (NY, CA, TX, Fl)	8				
2 each in second tier populated States(OH, IL, PA, MI, NC)	5				
additional rural sites	10				
total	***74***	***32***	***13***	***11***	***18***
note:allocation does not cover every major, large, medium sized city in United States; states lacking cities > 250,000 provide rural coverage					

Extended Discussion – Design Concerns

Given the practical resource constraints of less than 100 stations, there is a possibility of an inadequate network design due dilution effects. This concern is balanced by the expectation thatLlevel-2 sites are only minimum recommendations that serve as models for additional network modifications (not unlike the PM2.5 speciation program where the majority of State SIP sites operate similarly to the National trend sites). While the proposed allocation scheme is based largely on population and existing EPA regions, the intention is to set the basic design goal and allow for regional flexibility to choose the most appropriate and practical locations.

There may be more overlaps in siting needs for the multiple objectives. For example, long-term epidemiological studies are served by a cross-section of different cities with varying climates, source configurations and air quality characteristics. Air model quality evaluations require similar locations, as well as proportionately more information on rural and background locations, as well as vertical understanding the atmosphere (and beyond the scope for NCORE). Siting for accountability purposes benefits from "representative" locations but requires as much information in rural locations as urban given the difficulty of separating source signals in urban environments (e.g., nitrogen in urban locations is dominated by mobile sources, whereas in selected rural locations, such as CASTNET sites, the emission signals form major utility sources is less effected by area wide sources.

What Role Will EPA Play in NCore Site Approval?

For Level-1 sites, because these are considered "supersites," the location of such sites will be determined by EPA at the national level, in cooperation with the appropriate state or local agency.

Level-2 sites will be recommended by each state or local agency or tribe and must be approved by EPA at the national level. Approvals will be made based on the degree of consistency with the NCore objectives for Level-2 sites.

Level-3 sites will be recommended by each state or local agency or tribe and must be approved by EPA at the regional level. These sites must show consistency with the Level-3 site objectives.

Finally, the flexible local monitoring sites will not require EPA approval. State or local agencies or tribes must notify EPA of these sites, but EPA will not have oversight approval authority for these.

How Will NCore be Funded?

Within a zero sum constraint, there are opportunities for substantial savings from existing air monitoring programs through divestments (see next two questions), and those savings can to a long way toward meeting the NCore goals and objectives, including the local flexible portion of the program. Where possible, there can be a reallocation of workforce resources where monitoring staff transition from older to newer technologies. For example, the burden reduction associated with divesting from a manually labor-intensive PM2.5 FRM system to a continuous system will require added attention to data management and interpretation. Many other examples exist such as PAMS operators applying their skills to air toxics measurements. Deficiencies in skill level and training resources need attention to facilitate implementation. Modest capital investments in new technology of approximately $12M are required to purchase monitoring instrumentation, and the QA and information transfer technology that underpins NCORE. An additional $2-3M annually is required to maintain Level 1 master sites that can continue technology transfer to routine networks dynamically, as opposed to current practices characterized by infrequent and often ad-hoc adoption of new techniques. Finally, quality assurance efforts must receive adequate support and be viewed as an integral aspect and part of the overall cost of environmental monitoring.

How Will the Needed Funding be Obtained?

It is expected that much of the funding for the Level-2, Level-3, and local flexible sites can be accommodated through the optimization of existing funding for the existing monitoring networks. There will be a concerted effort on the part of EPA working with the state and local agencies to secure the necessary funding for procurement of new instrumentation, and installing and maintaining Level-1 sites. Ideally, an explicit funding initiative would be identified for this strategy. In the absence of a strategy specific initiative, several focused initiatives (several $ million each) that service the strategy are being pursued:

- Real time Ambient Data System (OAR): ($ amount to be determined) covering extensive upgrading of telemetry systems and ITT components to service most of the ambient air networks

- PM implementation (OAR): ($ amount to be determined) for an assortment of air quality analysis tasks including cost benefit analyses, air quality modeling and a separate task for upgraded air monitoring to address accountability needs associated with measuring precursor and related pollutants. These resources would support NCORE Level 2 and existing CASTNET sites.

- Clear Skies Initiatives: ($ amount to be determine) for an initiative similar to PM implementation that would include mercury.

Why Do We Need to Divest in Existing Monitors?

Divestment in monitors and monitoring sites is part of a natural evolution of networks as depicted earlier in Figure 1. The motivation for divestment is simply to optimize network performance. Under the current level funding assumption, divestments in certain network components must occur to accommodate increases in advanced technology, multiple pollutant and air toxics measurement systems. Selected monitoring stations can be upgraded by systems yielding vastly increased quantities of more insightful measurements increasing our ability to protect public health and manage air quality. This divestment will be based on network assessments using objective approaches that identify redundant measurement or low value sites and consensus building efforts largely on a region by region basis. Site reductions of 50% or greater for CO, SO_2, NO_2 and PM_{10} and 5 to 25% for ozone and $PM_{2.5}$ are recommended on a national basis, with specific details based on regional level assessments. In addition to a modest net reduction in $PM_{2.5}$ sites, approximately 50% of the sites operating FRM's should replace this filter based method with an approved continuously operating monitor.

Won't Divestments Decrease Our Knowledge of Existing Air Quality Conditions?

To the contrary, the utilization of resources from divestments will increase our knowledge of what's going on in the atmosphere. For many pollutants, which have decreased to levels well below health standards, we are expending funds to maintain monitors which provide, now, little additional information to what we already know. It is much more prudent and effective to apply those resources to monitoring for pollutants and conditions which we know much less about, and which may pose greater health risks. Periodic assessments of our air monitoring networks will assure that we continue to optimize our resources for the public's benefit.

What is a Network Assessment?

A network assessment is simply a structured evaluation of a monitoring network to determine if the goals and objectives for that network are being met in the most efficient way. Networks can be viewed as local (e.g., within the jurisdiction of a state or local agency), regional (e.g., within the aggregate of several states with common air pollutant problems, or national (e.g., the aggregate of all the local networks.)

The NMSC has recommended that national assessments be conducted about every five years, the same interval that the Clean Air Act requires EPA re-evaluate the NAAQS. The NMSC also has recommended that local/regional assessments be conducted on a 2-3 year cycle.

What Assessments Have Been Done Already?

The EPA has recently completed a national assessment. The results showed the need for investing in new technologies, the opportunity for certain divestments, and the importance of conducting the local/regional assessments. EPA is currently working with its regional offices to conduct regional assessments, and/or work with state and local agencies to conduct local assessments. The upper Midwestern states led by a joint EPA-Region 5/LADCO-directed effort, have produced an initial assessment of their networks that includes emphasis toward investments in air toxics and reductions in criteria pollutant monitoring. All EPA regions have initiated these efforts with their States and these are targeted for completion by late 2002 or early 2003.

Extended Discussion – Results of the National Assessment

A national level assessment of the criteria pollutant networks was performed that assigned "relative value" to existing criteria pollutant monitoring sites for subsequent decision making on site divestments. The national assessment served as both a catalyst and information base for subsequent regional level assessments which convene stakeholders and experts of particular regions to better meld analytical findings with practical considerations.

The national assessment considered concentration level, site representation of area and population, and error uncertainty created by site removal as weighting parameters used to *determine relative "value" of individual sites. The most widely applied factor inherent in most assessment approaches is related to site redundancy and can be estimated in a variety of ways. The national assessment calculated error uncertainty by modeling (i.e., interpolating between measurement sites) surface concentrations with and without a specific monitor with the difference reflecting uncertainty (Figure 7). Areas of low uncertainty (e.g., less than 5 ppb error difference for ozone) suggest that removal of a monitor would not compromise the ability to estimate air quality in the region of that monitor as nearby stations would provide adequate acceptable predictions.*

The assessment approach was expanded to include additional weighting factors beyond error. Typical outputs for ozone networks (Figure 8) suggest that ozone sites clustered in urban areas yield less powerful information than sites located in sparsely monitored areas, especially in high growth regions like the southeast. This methodology was applied to all criteria pollutants with a variety of weighting schemes to provide a resource for more detailed regionalized assessments.

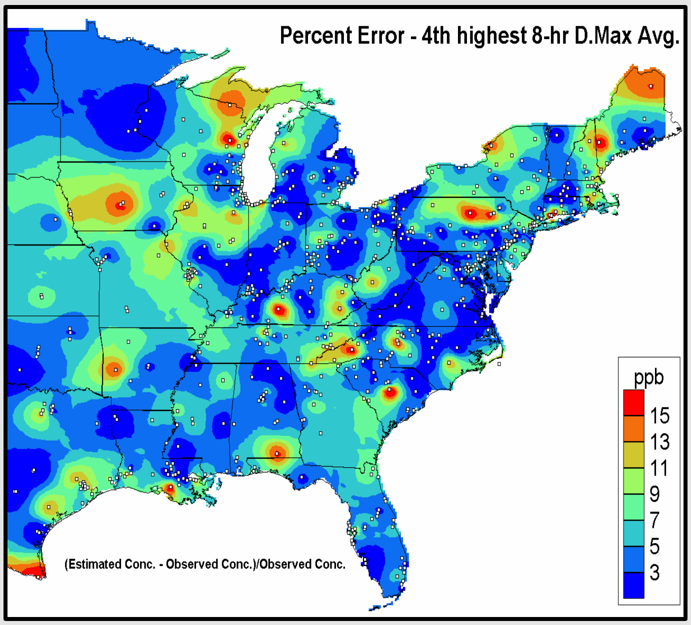


Figure 7. Surface depiction of estimated absolute errors in ozone concentrations produced by removing existing monitors on a site by site basis. Areas showing low errors (<5 ppb) suggest neighboring monitors could accurately predict ozone in area of a removed site. Areas of high error suggest necessity to retain existing monitors and perhaps increase monitoring.

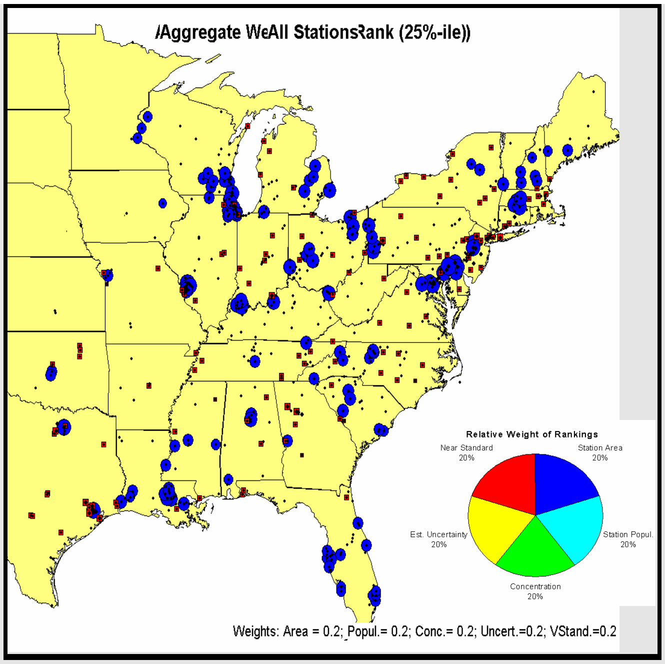


Figure 8. Aggregate assessment of 5 evenly weighted factors. Blue circles and red squares indicate the lowest and highest valued sites, respectively.

These assessments have renewed an interest in the application of various spatial analysis methods that have potentially wide-reaching applications beyond network reviews. Historically, the interpretation of monitoring data has been based on political and demographic grounds which can limit the full descriptive capacity of ambient data. For example, a strict regulatory use of a monitor limits applicability to a county or MSA, with little consideration for the actual extent of representation provided by either an individual or collection of monitors. Spatial analyses strive to reflect more realistic concentration patterns that exist (Figure 9) and are extremely relevant to concepts such as area of influence and area of violation that were addressed in the FACA discussions on integrating regional haze, PM fine and ozone in the mid-1990's.

As part of the strategy, a workshop of national experts in spatial modeling was held to develop a plan for implementing techniques as a more formal component of air quality management. These techniques are viewed as a more credible and improved use of air quality data in program management and reflect another merging of monitored and modeling approaches, as discussed above. At this time, EPA is developing the technical capacity for these techniques which will then be integrated into air program policy.

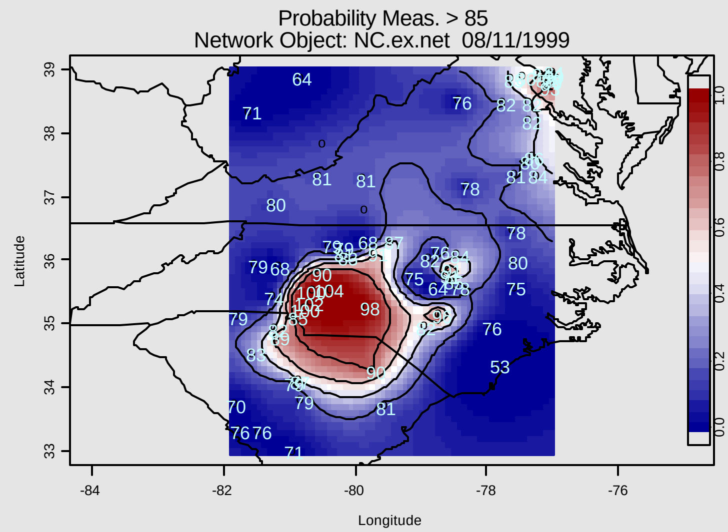


Figure 9. Surface depiction of probability of exceeding daily ozone value of 85 ppb over a three year period. Coherency in the spatial boundaries better represents actual concentration estimates relative to a political boundary approach, and carries the potential for more sound air quality planning and progress approaches.

Three assessment-based efforts have also been directed at PAMS:

- *A joint STAPPA/ALAPCO/EPA workshop was convened in early 2000 to develop overarching needs and changes for the PAMS program. Consensus was reached that PAMS objectives should emphasize accountability or tracking of long term progress of VOC and NOx emission reduction programs and develop a revised, downsized list of PAMS monitoring requirements. Any resource savings would be for local/State agency discrertion to address other monitoring needs such as air toxics or specialized ozone precursor studies, and enhance the data analysis and interpretation of monitoring results.*

In restating PAMS objectives emphasizing long term trends, there should be a reduced emphasis on the more diagnostic aspects of PAMS regarding ozone formation. That is, do not expect PAMS to be the principal technical tool to describe the complicated atmospheric process aspects underlying ozone formation. PAMS should be viewed as a supporting complement to more intensive field study campaigns that address diagnosing of atmospheric chemistry phenomena and air quality model evaluation. PAMS has been subjected to considerable criticism based on a perceived lack of data uses to concerns regarding measurement quality.

Much of this concern can be attributed to an over-marketing of PAMS that suggested the program would find the silver "bullet" in defining the most efficient ozone control strategy and a desire for immediate results, which conflicts with the multiple or decadal *years required to "see" atmospheric changes. Regardless of the motivation for change, the PAMS program should result in a more focused approach with reasonable expectations. The intrinsic value should not be questioned, as PAMS is the only program providing for routinely measured volatile organic compounds, a key precursor or direct contributor to for most pollutant categories.*

- *An assessment of the PAMS networks through the Northeast and mid-Atlantic States sponsored by NESCAUM, MARAMA and EPA provided specific suggestions for downscaling PAMS. Many of those recommendations were incorporated in revised PAMS monitoring requirements.*

- *A sub-group of the regulatory workgroup under the NMSC developed a series of recommended changes, including: reduction of speciated VOC measurements at non type-2 sites, addition of CO and or continuous TNMOC monitors as surrogates for VOC compounds and replacement of NO/NOx monitors with NO/NOy monitors.*

In summary, then the main findings of the national assessment are as follows:

- ***Investment Needs**: New monitoring efforts are needed to support new air quality challenges, including monitoring for air toxics and new technology for criteria pollutants. Air toxics have emerged as a top public health concern in many parts of the country. Although guidance for deploying a national air toxics monitoring network is still under development, substantial resources appear to be necessary for this monitoring, given the cost to sample for a core set of 18 compounds for one year (i.e., about $60K per site). New technology, especially continuous measurement methods for pollutants, such as fine particles, are needed to provide more complete, reliable, and timely air quality information, and to relieve the burden of manual sampling. Resources and guidance are needed for this activity, as well.*

- ***Divestment Opportunities**: To make more efficient use of existing monitoring resources and to help pay for (and justify additional resources for) the new monitoring initiatives noted above, opportunities exist to reduce existing monitors. Two areas of potential divestment are suggested. First, many historical criteria pollutant monitoring networks have achieved their objective and demonstrate that there are no national (and, in most cases, regional) air quality problems for certain pollutants, including PM10, SO2, NO2, CO, and Pb. A substantial reduction in the number of monitors for these pollutants should be considered. As part of this adjustment, it may be desirable to relocate some of these sites to rural areas to provide regional air quality data. Second, there are many monitoring sites with only one (or a few) pollutants. To the extent possible, sites should be combined to form multi-pollutant monitoring stations. Any resource savings from such divestments must remain in the monitoring program for identified investment needs. A reasonable period of time must is required to smoothly transition from established to new monitoring activities.*

- ***Importance of Regional Input**: The national analyses are intended to provide broad directional information about potential network changes. Regional/local analyses are a critical complement to the national analyses, and are necessary to develop specific monitoring site recommendations. To this end, EPA must allow states and regional organizations sufficient time (e.g., at least six months) to conduct adequate regional/local analyses.*

Has Anyone Identified Potential Policy Implications as a Result of these Network Changes?

Removal or relocation of monitors with historical regulatory applications creates a challenging intersection of policy and technical applications. Network assessments produce recommendations on removing or relocating samplers based largely on technical merit. In some instances, these recommendations may be in conflict with existing policy or other needs. For example, a recommendation that an ozone monitor be discontinued in a "non-attainment" county due to redundancy of neighboring sampling sites raises interesting policy/technical issues. These and other issues require attention in concert with technical recommendations developed through assessments. It should not be assumed that policy should override a technical recommendation, nor should technical approach override existing policy. Rather, reasonable solutions can be achieved on a case-by-case basis. To that end, the NMSC includes EPA staff focused on policy issues. In the intersection between policy and network optimization, issues are being identified. The total perspective of such implications has not yet fully been fleshed out.

Will There Be a Need for Any Regulation Changes?

Yes. Revisions in the regulations for air monitoring and quality assurance are needed to implement network changes associated with deploying new technologies and measurement systems.

What Will Those Changes Entail?

Monitoring regulation revisions are needed to remove potential obstacles such as outdated site number requirements, and to foster technically creative instrument approaches. The monitoring regulations remain the most authoritative guide for monitoring agencies and ultimately will serve as the principal communications tool to convey products of this strategy, ultimately establishing NCore as the umbrella for federally mandated monitoring. The specific changes being considered include:

- new minimum requirements in criteria pollutant monitoring to enable action on results from network assessments and continuous PM monitoring implementation plan (CFR Part 58)

- insertion of NCore as a replacement for traditional NAMS/SLAMS components (CFR part 58)

- introduction of new provisions for continuous PM2.5 monitoring including regional equivalency (CFR parts 53 and 58), and broader correlated acceptable continuous (CAC) monitoring applications (CFR part 58)

- revised PAMS monitoring requirements emphasizing accountability as a primary objective and a reduction in monitoring at non-type-2 sites (CFR part 58)

- restructuring of quality assurance (CFR part 58)

- revised national equivalency specifications for $PM_{2.5}$ and $PM_{(10\text{-}2.5)}$ that will be based on updated data quality objectives and structured to accommodate continuous technologies (CFR part 53)

- specifications for $PM_{(10\text{-}2.5)}$ Federal Reference Method

Will There Be Changes to the Required Minimum Number of Monitoring Sites?

Yes. Table 4 shows that the existing number of sites required by current regulations, and the proposed number of required sites under NCore. Note that the number of sites reporting data to EPA far exceeds the number of sites required by regulations, and at least for the key pollutants, ozone and PM, this condition is expected to continue. Note, too, that the minimum number of **required** sites for both ozone and $PM_{2.5}$ will actually increase under these regulation changes.

Table 4. Summary of previous and proposed network requirements for criteria pollutants.

Pollutant	current number of sites reporting data to EPA	current NAMS requirements	Proposed[1] minimum sites in regulations[2]	NCORE[1] Level 2
SO_2	592	200	74[5]	74
NO_2	437	100	74[5]	74
CO	498	130	74[5]	74
Pb	247	10	10+[4]	(10)[4]
O_3	1167	300	300-500[2]	74
$PM_{10}/PM_{(10-2.5)}$	1200	235-735	120-400[2,3]	74
$PM_{2.5}$	1100	0 (goal only)	300-575[2]	74

1 -minimums expected to be included within NCORE Level 2 sites

2 - includes 74 Level2 sites

3 -unknown number of $PM_{(10-2.5)}$ sites

4 -10 trend sites (encouraged to locate at Level 2) plus source specific sites

5 -small number (<10) to be retained in existing NAAQS violation areas

When Will These Changes be Promulgated?

EPA is scheduled to propose new PM standards that potentially include changes in $PM_{2.5}$ and a new $PM_{(10-2.5)}$ (PM-coarse) standard in 2003 or 2004. The monitoring regulation changes, associated with this strategy and those addressing the new standards, are expected to be coordinated and submitted as one complete package.

Will There be Changes to the Quality Assurance (QA) Program?

Yes. A restructuring of the QA program, a major implementation component of air monitoring, must accompany the comprehensive rethinking in air monitoring programs.
The goal for this QA Strategy was to take a philosophical look at QA with the premise: “what are the appropriate quality system elements and activities for an ambient air monitoring program.” Once this was determined, any ambient air monitoring program that addressed these quality system elements/activities in an appropriate manner for their objectives, would have an

acceptable quality system. This system creates a more flexible approach to QA (graded approach to QA).

What Aspects of the AQ Program Are Being Considered?

There are several key recommended changes, including:

- Moving toward a performance-based process with data quality objectives;
- Improving the performance evaluation (e.g. audit) process;
- Phasing network deployments;
- Considerations for costing QA functions and funding of certain elements through the state/local/tribal air grant program;
- Developing certification/accreditation programs

Extended Discussion – Greater Details of the Proposed QA Changes

The Quality Assurance workgroup has developed a series (subset follows) of recommendations that are varying stages of implementation to update the quality assurance system and complement or facilitate tasks associated with this strategy
:

> *Using a* ***Performance Based Measurement Process (PBMS)*** *and* ***Data Quality Objectives*** *to develop acceptance criteria for Federal Reference and equivalent methods. OAQPS would be responsible for developing DQOs for federally mandated data collection efforts. DQOs for other data collection activities (i.e., DQOs for non-trends speciation sites) would be the responsibilities of the SLTs.*
>
> ***Phasing network deployment after full testing of monitors*** *to minimize start up problems related to rapid deployment in 1999 of sequential PM mass monitors.*
>
> ***Provide a reasonable estimate of the "cost of QA"*** *- Identify quality system elements for a "typical" SLT monitoring organization and provide an estimate of the costs of an adequate quality system. Use these estimates to provide a percentage of monitoring costs that should be allocated to the implementation of a quality system.*
>
> ***STAG Resources for NPAP*** *- The Workgroup endorsed the use of STAG resources to cover the NPAP program. STAG funds currently pay for the $PM_{2.5}$ Performance Evaluation Program (PEP). The NPAP program is currently being re-invented to a through-the-probe audit process. The added costs to each State to implement this new program is about 11K. More information on this suggestion is included in the performance evaluation section.*

Regulation Changes *- Regulation for the Ambient Air Monitoring Program quality system can be found primarily in 40 CFR Part 58 Appendix A and B. These two appendices were the focus of the Workgroup. However, quality control criteria can also be found in 40 CFR Part 50 that describe the method requirements.*

Development of "certification/accreditation" programs *- An accreditation process would foster a level of consistency across the nation. Suggested programs include:*

Upper Management - QA 101, basic QA concepts
Ambient Air Monitoring Manager
Site Operator
Calibrators
QA Technician
Laboratory Scientist
QA Manager
Information Manager

Annual QA Conference *- coinciding with the National QA Conference in order to take advantage of the training modules put on by EPA Quality Staff at the National Meeting. The first conference was held in April, 2002 in Phoenix, AZ*

Develop a generic QAPP *- Starting with the G-5 EPA QAPP Guidance, develop a generic ambient air monitoring QAPP software product that would allow the SLTs to input the correct information into each section for their particular monitoring program.*

Data Certification and Quicker Data Access on AIRS*...accelerate data review process through transfer technologies (data loggers, telemetry, automated quality control) for automatic transfer of routine and quality control information to central facilities. Included in this would be quality control systems for automating various QC checks like zero/span checks or bi-weekly precision checks, and change certification from a biannual to a quarterly basis.*

Performance Evaluations
Performance evaluations (PE) are a type of audit in which the quantitative data generated in a measurement system are obtained independently and compared with routinely obtained data to evaluate the proficiency of an analyst or laboratory. The types of audits in this category include: the National Performance Audit Program (NPAP), Standard Reference Photometer Program (SRP), PM2.5 Performance Evaluation Program (PEP), as well as any SLT's audit programs. Recommendations included:

> ***Avoiding redundant programs*** *- It is known that the goals of the NPAP program are similar to the goals of various SLT programs (i.e., the CARB through-the-probe audit program). In order to avoid performing multiple PEs and reduce QA costs, the Workgroup recommended defining an "acceptable" PE program and determining which SLT are performing these. NPAP would not have to include*

these sites within their PE network other than to establish some level of consistency/equivalency.

Combining NPAP and PEP Program- *The Workgroup endorsed the revision of NPAP to a through-the-probe audit approach and agreed that the STAG funding mechanism of the current $PM_{2.5}$ PEP could be enhanced to include NPAP.*

Revising requirements for industry to contribute payments to NPAP
Data Quality Assessments- (DQAs) should be performed by OAQPS beyond PM2.5 FRM mass DQAs to all national level programs

Developing DQA tools - Similar to the $PM_{2.5}$ DQO software that is being modified as a DQA tool, as DQO development on the other criteria pollutants move forward (recommendation in another section above) DQA tools will also be made available. It is anticipated that these tools would be integrated with AIRS.

The Monitoring Strategy Emphasizes New Technologies. What Sorts of Technologies Are Envisioned?

Technological advances in communications and monitoring technology support several monitoring objectives. These advances include the emergence of information transfer technology (ITT) that facilitate timely delivery of data from instrument to user and enable off-site calibration of monitors, and a wealth of near-continuously operating particle monitors that measure direct chemical components of aerosols as well as light absorption, light scattering and indicators for gravimetric mass. Combined, these advances act to provide synergistic improvement in total data delivery and usefulness as the ITT can address added quality assurance needs of new instrumentation and provide the real time delivery to maximize benefit of continuous systems.

Are These Technologies Ready Now?

Against the backdrop of promising technologies is a recognition that many of these emerging methods simply are not ready for widespread application in routine networks yet, either due to sporadic performance results, lack of adequate trial testing, commercial availability or burdensome and complex operational protocols. Therefore utilization of the products warrants careful scrutiny for acceptance into the NCore network. EPA will work toward providing information to state and local agencies and tribes regarding such technologies.

What Key Technological Improvements Can Be Acted on Now?

Two firm recommendations should be acted on:

- **Continuous PM2.5 monitors should gradually replace up to 50% of the current FRM filter instruments over the next 5 years.** EPA staff have developed an implementation plan under consultation with the Clean Air Scientific Advisory Committee Subcommittee on PM monitoring. This plan introduces the use a new Regional Equivalency approach based on the data quality objective (DQO) process that addresses strong dependence on climatology and aerosol composition on sampler performance and provides guidance on statistical approaches to integrate continuous monitors with existing FRMs. Forthcoming modifications in regulations need to successfully relieve burden for existing agencies to accommodate continuous methods. Many of the lessons learned from September 11 are relevant, as the existing FRM network provided insignificant value relative to a handful of existing and newly installed continuous samplers.

- **ITT upgrades should be deployed in all NCORE level 2 sites as well as level 3 sites supporting AIRNOW.** This will enable rapid dissemination of air quality data to the public. As part of this process, there also needs to be automated preliminary QC data checks to assure that obviously erroneous information is flagged and not passed to the public.

Extended Discussion – ITT Performance Details and Consideration

Table 5 provides suggested performance specifications for these systems.

Table 5. National Core Network (Level II and III) Information Technology Performance Needs

Performance Need	*Performance Criteria*	*Notes*
Sample Periods	*1 minute, 5 minute, and 1 hour data*	*1 minute to support exposure, 5 minutes to 1 hour data to support mapping and modeling. 1 hour data for Air Quality Index reporting and NAAQS.*
Data Delivery	*- 15 minutes within network* *- 1 hour nationally*	*Delivery every 15 minutes of 3 sample intervals each 5 minutes a piece. Exposure data could be supplied at 1 minute intervals for episode monitoring and as needed.*
Low Level Validation	*- Last automated zero and QC check acceptable* *- Range check acceptable* *- Shelter parameters acceptable* *- Instrument parameters acceptable*	*Other low level validation may be necessary*
Data Availability	*- all qc data, operator notes, calibrations, and pollutant data within network* *- Low level validated pollutant data externally*	*Create log of all monitoring related activities internally. Allow only validated data to leave agency network.*
Types of monitoring data to disseminate – externally	*- continuous and semi-continuous pollutant data* *- accompanying meteorological data* *- associated manual method supporting data (for instance FRM sample volume).*	
Additional data for internal tracking	*- Status of ancillary equipment such as shelter temperature, power surges, zero air system*	
Relevant site information	*Latitude, longitude, altitude, land use category, scale of representativeness, pictures and map of area.*	*Other site information may be necessary*
Remote calibration	*Ability to initiate automated calibrations on regular schedule or as needed.*	
Reviewing calibrations	*- allow for 1 minute data as part of electronic calibration log*	
Initialization of manual collection methods	*Need to be able to remotely initiate these or have them set at an action level from a specific monitor*	

Other Performance Considerations

While some of the desired performance criteria can be identified in units such as sample period or data delivery time, others are more qualitative in nature. The following list identifies some of the other important considerations of an information transfer to support Ncore:

- *Linking of data sets and synchronization of stations to promote nationwide access*
- *Have battery back-up such as a UPS to ensure no data loss during power outage*
- *Self-initializing to minimize power interruptions*
- *Graphical display of data*
- *Ability to perform simple data analysis/aggregation tasks*
- *Automated AQS data processing after validation*

Optimizing Costs of Telemetry Systems to Support Ncore

Although there needs to be an initial investment in upgrading information technology systems to support Ncore, there is an expectation that the added value to the program, by enhancing the timeliness and frequency of data delivery, will more than account for the cost. Also, since the performance criteria presented in this section lend themselves to utilizing state of the art telemetry systems such as high speed internet and satellite there will no longer be a need for leased land lines to support low speed modems. Ironically, many options for state of the art telemetry systems are lower in cost than conventional systems. However, due to the cost and burden of implementing a new system many monitoring agencies are reluctant to take pursue this kind of a project. Consider the following conventional data flow model where there are 5 long distance calls each time the network is polled. (See Figure 10.)

Now consider a possible new approach utilizing a combination of modems and high speed internet with no long distance calls. The savings from avoiding long distance calls can more than make up for the cost of the internet connection and local phone systems. Then the cost of frequent polling can substantially reduced. The NCORE sites would be linked to enable real time access to multiple pollutant measurements across the nation. (See Figure 11.)

]

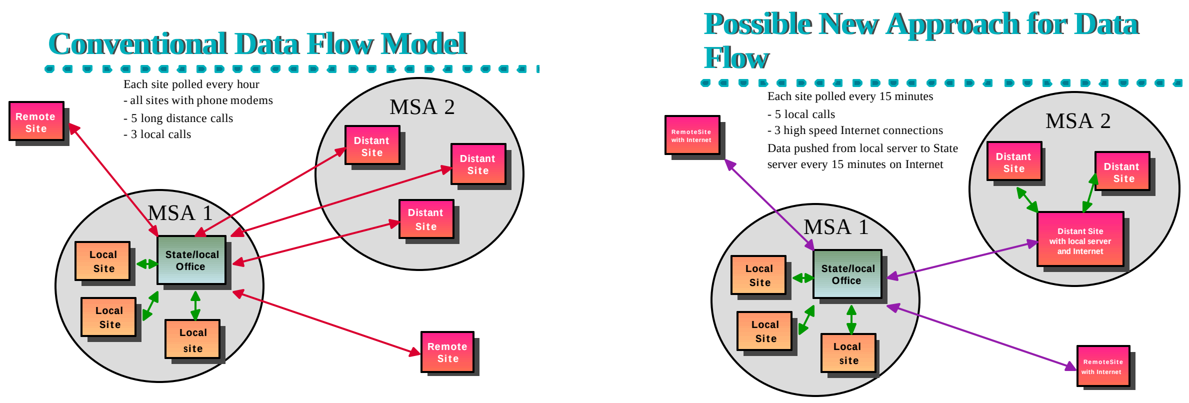


FIGURE 10. Comparisons of data flow paaths using conventional and advanced information transfer approaches.

FIGURE 11. Concept view of linked Ncore sites providing immediate air quality characterization across the Nation.

How Will the "New Monitoring Strategy" Be Communicated?

Clearly the success of implementing a new paradigm in air monitoring requires a comprehensive public outreach and communications process. Without this process, there may be public misconceptions about the overall benefits of the strategy. To this end, EPA will work closely with state and local agencies in preparing various outreach materials, which can be used in conjunction with local public workshops, to explain the details of the Strategy. The products include:

- This **summary document** which tries to concisely capture the essence of the Strategy.

- **A more detailed Draft Strategy Document** which provides much more in-depth discussion of each of the Strategy's components. The NMSC is interested in receiving comments from all parties interested in reviewing that document.

- **A fact sheet** explaining the technical need for a revised air monitoring strategy. This item will target all audiences except those already familiar with the National Strategy.

- **A quarterly newsletter**, beginning August, 2002 and available through EPA's website, which will provide updates on the status of the Strategy as it moves from the development to the implementation phase. The target audience here is agency, tribal, and all public/private representatives with an interest in the latest progress for the National Monitoring Strategy

- **A Monitoring Strategy brochure**, which is targeted primarily for the general public. This trifold-type brochure will be developed discussing the points covered in the Strategy in a simple, straightforward manner. The brochure will be jointly developed by STAPPA/ALAPCO and EPA, for distribution in late Fall of 2002 or early Winter 2003.

Is There Any Scientific Peer Review of the Strategy?

It is expected that there will be such a peer review, principally through the Clean Air Scientific Advisory Committee (CASAC) starting in Fall, 2002. Additional input has been, and will continue to be, sought through numerous other opportunities, including: the Air Quality Research Subcommittee of the Committee for Environment and Natural Resources, January, 2002; NARSTO Executive Assembly Meeting, May, 2002; PM Supersite Principal Investigator Meeting, June, 2002; PM Health Centers Meeting, July, 2002.

What Are the Next Steps?

The monitoring strategy will proceed into a larger communications and outreach stage over the next two years. A concerted effort to engage the Scientific community, other federal agencies, environmental groups, industry and related disciplines (ecosystem/deposition, global transport, intensive research field programs, NOAA-NASA Satellite data) must be advanced to not only communicate the benefits of the strategy, but to explore additional leveraging and optimization opportunities. These outreach efforts will provide an avenue for constructive feedback, and used as leverage to raise or redirect resources to support identified funding gaps and other needs that are likely to emerge. Currently, no formal plan exists to move this larger integration forward, although discussions with NARSTO, CENR and the PBT monitoring strategy committee have been informed of (or advised on) this need. As the Strategy moves to a more formal review through CASAC, the NMSC intends to identify and act on the necessary steps to advance this integration. And in the near term, the NMSC will continue to refine details of the major components. EPA will continue to proceed in parallel with the NMSC and the science communities with regard to national network design, given the multi faceted orientation of NCORE.

What Are the Key Timelines?

The timelines are shown in Table 6.

Table 6. Strategy Timeline	
Draft Strategy document for NMSC review	July, 2002
NMSC meeting for release of document	July 30, 2002
Draft final document for public comment	Sept.- Oct., 2002
Draft Regional network assessments NMSC Review of Comments and Finalization of the Monitoring Strategy Document	October, 2002 January 2003
Final Regional network assessments	March, 2003
CASAC review	Est: 2002-2003
Outreach to science and environmental groups	2002 -2003
Monitoring regulations proposal to NMSC	December, 2002
Monitoring regulations proposal to OMB	Mar, 2003
Monitoring regulations proposal in FR	June, 2003
Monitoring regulations final	Dec, 2003
Deployment	2003 – 2007